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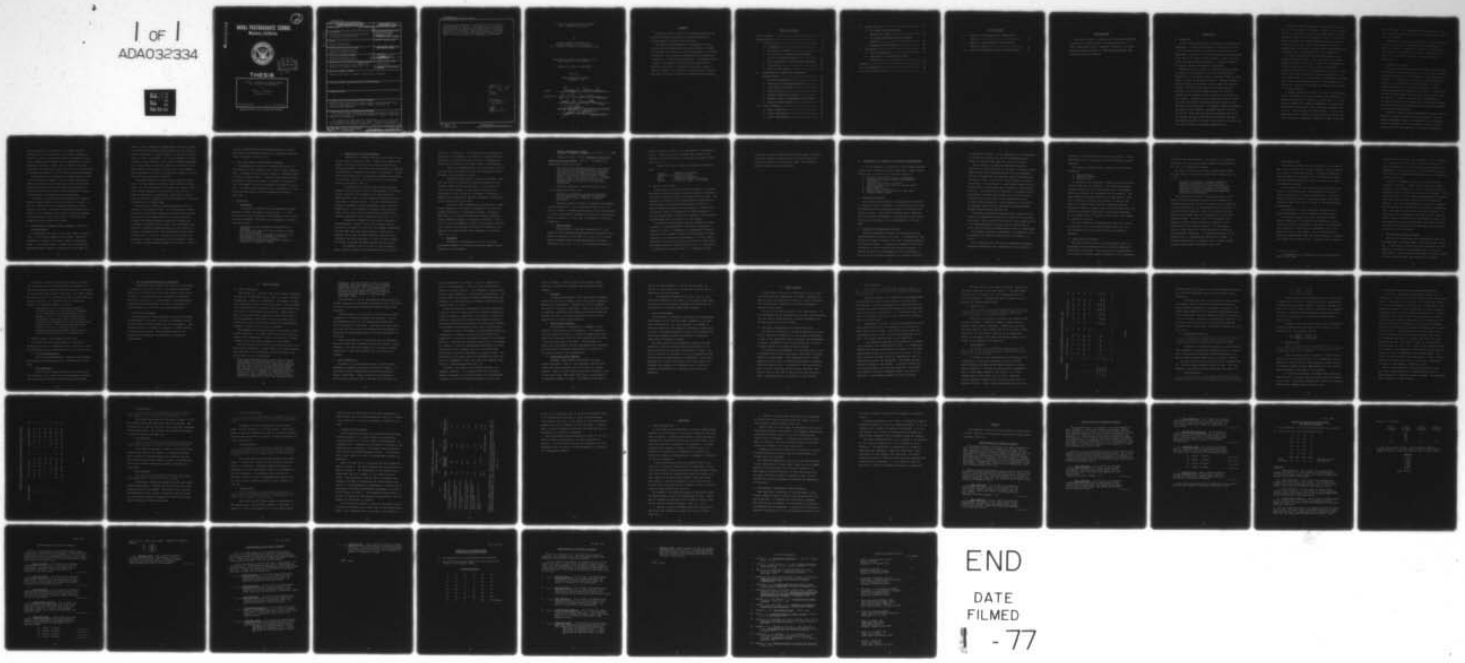

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

A MODEL FOR MEASURING EFFECTIVENESS
IN A SECURITY ORGANIZATION

by

Ralph W. Schneider

September 1976

Thesis Advisor: B. H. De Woolfson

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ABSTRACT

This study effort validates the appropriateness of employing the Delphi technique to establish measures of effectiveness for support type functions.

The reason some processes are unmeasurable and the difficulties of measuring outputs are discussed. A model is developed for determining the effectiveness of a security organization and a step-by-step procedure is provided for instituting an effectiveness evaluation. The preparation of a Delphi questionnaire for establishing goals and for weighting the goals is presented, from which a panel of security experts in an iterative process assigns values to each goal to provide a medium for measuring effectiveness.

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I. INTRODUCTION

A. BACKGROUND

In most industrial processes, outputs are definable and measurable. A lathe can turn down 2" steel rods to 1.896" ± .005" and the output of the machine is quantifiable and measurable. And so it is with other product type operations. Output may be in inches, pieces, pounds or other units and its attributes are easily measurable. Generally speaking, the outputs of most processes are measurable.

Because output is a factor in computing effectiveness, if output is not measurable, how then is effectiveness determined? In the public sector, processes abound in which output is vague or difficult to define. Examples appear in such activities as recreation, public health and national defense. Quantifying the extent of physical security provided by our national defense effort is a baffling problem for the experts who are involved in its study on a daily basis. Measures such as flying hours used or extent of border patrolled are meaningless when related to the security of the population. An aircraft company can measure its output by the number of airplanes leaving its plant. But the Air Force unit that uses the airplanes and has as its mission the task of protecting the coastal perimeter from enemy intrusion finds that just defining its output can be a most difficult and perhaps impossible job.

But why put all this emphasis on output? If we do our job is it not enough? The answer of course is not a simple yes or no. By doing our job we gain some degree of satisfaction in knowing we are producing something. And if our product measures up to some preselected goal we are also effective in our job. But, if the output is vague or unmeasurable, and no goal or objective has been established, we may not only be unproductive but also ineffective.

Our capitalistic economy established profit as the primary goal for industry. Profit is that which enables business concerns to survive. In fact, in a laissez-faire economy, earned profit would be the only criteria for determining whether or not a business should survive. Maximizing the profit while holding expenditures constant is a very viable measure of effectiveness. Government activities however are seldom engaged in profit making endeavors so a new set of guidelines is required for effectivity measures in the public sector.

A concept analogous to profit, one that is increasingly used by government when profit measures are nonexistent, is benefit-cost analysis. Charles J. Stokes [Ref. 1, p. 184] cites an example of a highway constructed in a developing nation where the benefit to cost ratio was computed to be 8.3 to 1. But this was the direct benefit. A factor not considered in the calculations was the loss of the agricultural land with a subsequent reduction in food, fibre and

fuel production. It is possible that more productive use could and should have been made of the capital funds used to build the highway.

Benefit-cost analysis can suffer from the same malady as effectivity analysis - the difficulty of measuring the benefit or output. Measuring the benefit is usually much more difficult than measuring the cost. Benefits may be difficult to express in monetary terms if they have no market price.

B. STATEMENT OF PROBLEM

A model has been developed by Lyden and Miller for evaluating program effectiveness [Ref. 2, p. 141] that requires a complete description and measurement of each variable of a program. If a variable or portion of a variable cannot be measured, the model cannot be fully applied. In many government activities, indicators that might be used to judge effectiveness are difficult to quantify. A Naval Air Station provides support and services for other activities and exists as a general rule only as a support activity. The major portion of work performed by Air Station personnel is of the overhead type, although some direct and reimbursable effort is accomplished.

A Naval Air Station Security Department performs various functions related to base and physical security. The Air Station Commanding Officer is responsible for all security within his command, and for the physical security of all facilities within the confines of the Naval installation.

Physical security is that part of an overall security program which is concerned with the physical measures designed to prevent unauthorized access to equipment, facilities, material and documents and to safeguard them against espionage, sabotage, damage, theft or other covert acts which would in some degree lessen the ability of the activity to perform its mission or affect overall material interests.

The difficulty of determining the effectiveness of this type of operation is apparent from the above description. Effectivity measures are determined by describing mission related functions, identifying quantitative indicators, assigning objectives or goals to each indicator and measuring the degree of achievement of the objectives.

The Security operation has evaded attempts to quantify mission related output by the very nature of its work. By skillful application of cost benefit analysis it may be possible to devise a method for evaluating alternatives of choice, but no treatment has evolved for applying measures of effectiveness to this type of work. This paper will attempt to devise applicable measures.

C. DIFFICULTIES OF MEASURING SOME PROCESSES, OUTPUTS OR ACCOMPLISHMENTS

All processes have value in that some money is paid for them. In the private sector of our economy, values are determined in markets, and value is equal to the market price. In the public sector, outputs that are not easily measurable cannot equate to a market price that does not

exist. Here the problem of unmeasurables forces an innovative method for evaluating effectiveness that is foreign to private enterprise. A direct example is a Security Department in a Naval Air Station. How do you measure the effectiveness of base security? The number of persons apprehended for some security violation might give a hint as to the seriousness of the problem. But how deep is the problem? What percentage of the total violators are caught? Just how effective are the security operators?

The problem might be viewed from the opposite perspective. How many workers have never been cited for a violation? Or, what percentage of our assets are intact? Would any of these measures be a reflection of how well the security department is performing? Regardless of how we view the situation, measuring the effectiveness of a security organization is a complex task.

The police are generally assumed accountable for increases in all types of crime. It is questionable whether they should be thus held responsible any more than the Fire Department is held responsible for the number of fires. Although both agencies employ preventive strategies and investigate incidents after the fact, fire departments are rated for insurance purposes primarily on their ability to minimize the damage due to fires rather than on the number of fires [Ref. 3, p. 454]. One can view the police role similarly, as that of minimizing the harm caused by crime - or caused by other problems handled by the police. There is

a major difference between developing measures of police performance and developing measures to determine effectiveness of programs to reduce crime.

D. THE SIGNIFICANCE OF EFFECTIVENESS MEASURES

An organization's mission is characterized by one or more objectives which represent the output of that organization. A manager is given certain inputs, or resources which he uses to produce outputs. After the outputs are generated, performance feedback information is needed to indicate how well the manager utilized his resources to produce the outputs. In effectiveness measures we are concerned with a comparison between present period performance and stated objectives.

E. DEFINITIONS

1. Objectives

A situation or condition which responsible program personnel consider desirable to attain [Ref. 2, p. 145]. The objective should contribute to attainment of the mission. To permit subsequent evaluation, the statement of an objective must specify

- The nature of the situation or condition to be attained.
- The quantity or amount of the situation or condition to be attained.
- The particular group of people or portion of the environment in which attainment is desired.
- The geographic area of the program.
- The time at or by which the desired situation or condition is intended to exist.

2. Productivity or Output Measures

Productivity is broadly defined as the ratio of output per unit of input over time. Productivity compares the amount of resources used with the volume of products or services produced. In the long run, productivity is improved by innovation or changes in the means of production. In the short run, productivity is improved by raising the efficiency with which resources are utilized within the existing system of production [Ref. 4].

The productivity concept refers to an accurately measured total physical output of end-products of an organization, divided by the measure of the total amount of resources used, such as total number of man-hours worked or total cost in constant prices. In order to determine the changes in aggregate outputs and factor inputs, and thus productivity, it is necessary to combine unlike types of output and of input units by weights that indicate their relative importance for the purpose at hand [Ref. 5, p. 8].

Productivity indices are not precise measures of productiveness. However, one of the principal uses of productivity indices is in the area of manpower forecasting for both short and long-range planning. Productivity measures can be used to assess manpower utilization and allocation and very importantly, it can be used to assess the effect of capital equipment expenditures on output.

The emphasis here as in much of the private and public sector has been in increased productivity with no

mention of effectivity. The literature on productivity or efficiency is voluminous. A plethora of studies have been undertaken and numerous models developed for determining productivity indices but few works exist on effectiveness.

There is an awareness that has been growing over the last few years that there is a need for measures of effectiveness in relationship to costs.

Effectiveness has been a concern of engineers since 1887 when Arthur M. Wellington wrote his treatise on the economic theory of Railway Location. It was during the 1930's that the concept of cost benefit analysis into evaluation of public works was introduced. This was an approach that compared the benefits translated into dollars with the equivalent dollar cost.

During the 1940's Eugene Grant brought about a widespread awareness on the part of engineers of the need for economic evaluation of engineering projects. Following World War II, the field of operations research provided a greatly expanded viewpoint of economic evaluation. Tools such as linear programming, methods of optimization, and the like, coupled with the means for solution afforded by the computer, have made possible more meaningful evaluations [Ref. 6, p. 2, 3].

3. Efficiency

Efficiency is described as the ratio of actual performance numbers to standard performance numbers usually expressed as a percentage.

$$\frac{\text{ACTUAL PERFORMANCE (NUMBERS)}}{\text{STANDARD PERFORMANCE (NUMBERS)}} \times 100$$ [Ref. 7, p. 588]

Ireson and Grant in their Handbook of Industrial Engineering and Management, [Ref. 8] in speaking of organization efficiency state:

> The criterion of efficiency requires the fulfilment of the personal and individual objectives of those who are connected with the enterprise. This definition, it should be noted, departs somewhat from general business usage. "Efficiency," used in this sense, rests on the premise that the company has met the criterion of effectiveness and can fulfill its financial obligations.

Deniston, Rosenstock, Welch and Getting [Ref. 2, p. 143] describe efficiency as:

> The cost in resources of attaining objectives. The efficiency of a program may be unrelated to its effectiveness, adequacy, and appropriateness.

Efficiency then is defined in different ways depending upon objectives. For a production operation it is a ratio of actual to standard performance. For an organization it is the fulfillment of personal and individual objectives, and for a program it is the cost in resources of attaining objectives.

4. Effectiveness

Effectiveness is variously described as (1) the extent to which preestablished objectives are attained as a result of planned activity [Ref. 2, p. 143], or (2) a comparison between present period performance and stated objectives [Ref. 6, p. 3] , or (3) the desirable effects or

benefits gained by reason of the expenditure or incurring of a cost. Effectiveness also connotes some measure of performance or level of output of the benefit producing system [Ref. 9, p. 4].

Terms Often Used to imply the concept of effectiveness.

Utility	- Favored by economists
Productivity	- Results oriented
Worth	- Favored by engineers
Merit	- Operations research carryover
Benefit	- Favored by Bureau of the Budget

F. SCOPE OF THIS THESIS

In searching the literature on this subject, no current, applicable works were found to provide guidance on measuring the effectiveness of a Naval Air Station security force. The existence of studies in cost effectiveness, organizational effectiveness and personal effectiveness all strive to improve corporate profit as a final measure of effectivity. To provide a means of determining the effectiveness of a security organization a model for a measure of effectiveness was developed and is the subject of this thesis.

To determine effectiveness, specific measures of accomplishment for preestablished objectives are evaluated in relation to goals. A comparison of performance to stated objectives will provide a basis for determination of effectiveness. The mechanics of measurement in a profit making organization have been thoroughly described in other works. This model develops a method for arriving at (1) objectives, (2) quantitative indicators and (3) a concensus opinion

through an iterative process utilizing the Delphi technique. The Delphi method is credited with providing a method for selecting realistic and realizable goals and assigning specific weights for each indicator.

II. DEVELOPMENT OF A MODEL FOR A MEASURE OF EFFECTIVENESS

In the development of a model for effectiveness measures, several basic considerations are predominant. These considerations may be listed in the following sequence:

A. Describe organization mission requirements.
B. Determine the primary elements accomplishing the mission.
C. Identify quantitative indicators.
D. Establish quantitative goals or objectives for each indicator.
E. Weight each indicator.
F. Measure degree of achievement of each goal.
G. Evaluate effectiveness.

A. MISSION REQUIREMENTS

In a military establishment, the organization's mission is relatively easy to determine. A statement of mission may be obtained from the organization manual or directive from higher authority. The mission statement must be examined for goal directing statements. The phrasing of the mission will provide information for the development of the next step.

B. ELEMENTS FOR ACCOMPLISHING MISSION

Functions performed in support of the mission may be identified from the mission statement. A determination must be made of whether the effort will lead to accomplishment of the ultimate mission. A program may encompass several sub-objectives in order to achieve the ultimate objective. A careful review of the performance of the organization's activities will provide information of a primary objective

or subobjective nature. In the measurement of effectiveness, it is only the actions that lead to achievement of the primary or ultimate goal that are used in this model.

As an example, the security department registers vehicles for authorized entry on the base. A portion of the mission infers that unauthorized entry will be prevented. The act of registering the vehicles, while a necessary part of overall control, will not in itself satisfy the mission requirement. The prevention of unauthorized access will be accomplished by a gate check and a display of valid identification. The registering of vehicles is considered to be a subobjective and need be evaluated only if the sum of the subobjectives will be used in the determination of the ultimate mission objective. Major attention to objectives is necessary because of the importance of distinguishing between objectives and subobjectives.

The security program is characterized by several objectives which represent the desired end result of the security activities. Each objective implies one or more subobjectives or intermediate objectives which must be accomplished in order that the security program objective may be accomplished.

To perform a meaningful evaluation it is necessary first to establish the specific mission that the program is to fulfill.

In a conference with the Security Department Management Personnel, requirements were identified whose fulfillment is

essential to the attainment of the security mission. These requirements are in consonance with the department mission statement.

The security objectives were grouped into three major categories:

1. Base admission
2. Failure to secure
3. Response time

In describing the objectives, emphasis was given to providing those that are measurable. The department mission statement specifies that unauthorized access to equipment, facilities, material and documents will be prevented. The base admission category satisfies this requirement. Category 2, failure to secure, was selected to describe that part of the mission that requires safeguarding against espionage, sabotage, damage, theft or other covert acts, and protecting equipment, facilities, material and documents. It is intended that this objective will focus on the number of incidents occurring.

The last objective is response time which will provide an indication of the time delay between receiving a call for assistance and the actual arrival of the security personnel.

C. QUANTITATIVE INDICATORS

The most difficult part of an effectiveness study in a government service organization is to identify meaningful quantitative indicators. This step requires identification of the kind of evidence needed to determine that an objective

has or has not been achieved. The validity of a measure is the extent that an obtained score measures the characteristic that it is intended to measure.

The use of indicators to assess program effectiveness has been sharply criticized by Sheldon and Freeman [Ref. 10, p. 80].

> The use of indicators to measure outcomes of programs could lead to the most egregious statistical manipulation, for herein lies the arbitrary selection and control of variables that could virtually prescribe results without reference to important determining factors and casual interrelationships.

The criticism of the use of indicators points out the need to avoid an arbitrary selection and to perform an unbiased analysis and to select variables that are meaningful and contribute to the accomplishment of the mission. In accord with this reasoning, each of the primary security functions was broken down into elements that could yield a numerical value. The total value of the elements when properly weighted should provide an indication of the effectivity of the primary function. For the primary function "Base Admission", three quantitative indicators were selected. These are: (1) Unauthorized people in the control area; (2) Unauthorized vehicles on the base; (3) Unauthorized material or equipment that is brought aboard the base such as guns, explosives, drugs, etc.

D. ESTABLISHED GOALS

The setting of goals can be accomplished in a variety of ways, such as through an intuitive process, or more commonly by a review of historical trends. The method recommended here and applied to the Naval Air Station Security Department was formulated using the Delphi technique for reaching a concensus of opinion.[1]

Each indicator that was selected was evaluated for the extent to which achievement could reasonably be obtained giving consideration to existing constraints. A group of security experts through an iterative process established achievable goals that were to be used in the effectiveness determination.

The goals will provide a basis for comparison with actual performance to yield a measure of effectiveness.

It has been suggested that for a security function, nothing less than 1.00 reliability is acceptable. Reliability as used in this context is defined as the probability that a security violation will go undetected for a given period of time. As an example, one of the quantitative indicators establishes a goal for the percentage of unauthorized people in the control area. Precisely what is meant by

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[1] See Appendix for a description of the questionnaires used in this study.

stating that the goal for this indicator is 0.2? Generally, it is interpreted to mean that 98 times out of 100, unauthorized personnel will be prevented from entering or be apprehended in the control area. It also means that two times out of 100 unauthorized personnel will be undetected in the control area.

Security like safety, is one of the most difficult criteria to evaluate. Western society places an almost infinite value on human life. Yet, if some risks were not acceptable, space missions would never be undertaken. It is recognized that the risk of death accompanies many accepted human activities and that these risks are realized and accepted. The risk associated with air travel is accepted for the greater convenience over other modes of transportation. The same rationale can be applied to security. If some risks are not acceptable, the base would be forced to close. Even the expenditure of huge amounts of money, and the installation of the most advanced technological detection systems would not give 100% assurance that a security violation will go undetected.

E. ESTABLISHING WEIGHTING FACTORS

The relative contribution for achievement of goals can be established by the assignment of weights to each indicator. A high weight indicates that more importance or more emphasis is attached to that element than to one with a lower weight. The weights are determined in a manner similar to that for which values were assigned to the goals.

The group of security experts were asked to evaluate each indicator and the quantitative goal established for each and to assign a weight that would provide an indication of the relative contribution of each one. The Delphi method was used to arrive at a concensus opinion for the weighting of each indicator. To illustrate how the weights are applied, the following example is given:

> The specific goal for unauthorized people in the control area is 2%, and the weight assigned is 5%. (The total weight distribution to all elements is 100%). If a survey revealed 94% of the people in the control area were authorized to be there, the percentage of goal achieved would be 94/98 or 96%. The weighted program element is 96% x 5% = 4.8%. The sum of all the weighted elements will provide a total program valuation as a percentage of a possible 100.

F. MEASURE DEGREE OF ACHIEVEMENT OF EACH GOAL

Once goals have been established it is necessary to determine how well the organization did in meeting the goal. The measurement may be accomplished in one of several ways.

1. Survey the Population

This may be accomplished by taking a random sample, and through a statistical analysis a determination can be made.

2. 100% Inspection

While not very practical due to the high cost and time required, such a check can be accomplished by inspecting every vehicle and person coming aboard the station.

3. Use of Planted Personnel or Conditions

This method would require the selection of personnel to attempt an unauthorized entry. The number apprehended would give an indication of the effectiveness of the security force. The same method can be applied to classified material or open safes. By deliberately allowing selected unsecured classified material or safes, an indication of effectiveness can be had from the number identified.

G. EVALUATE EFFECTIVENESS

The evaluation of effectiveness will consider the degree of achievement of each goal, the weight assignment and the overall measure of effectiveness for the organization. Each indicator should be reviewed to determine if added emphasis is required in any area. The evaluation phase of the program is most important in arriving at a measure of effectiveness.

III. GROUP PROCESSES

A. GROUP INTERACTION

When faced with a decision that isn't clearly determined by very good information, we can turn to a group, a council, a committee, a panel or a commission. The reason for using this procedure is that with any group there is more information collectively in the heads of the group than there is in the head of a single member of the group. Unfortunately, that is not quite enough, because with any group there is more misinformation than there is in any one head, and by convening the group, you may be putting the misinformation together to come up with the worst judgement.

The standard way of using a group is to convene a face-to-face discussion. In short, issues are raised, they are hashed over, information is traded, and the group is asked to come up with their best judgement on the subject.

The traditional way of pooling individual opinions is by face-to-face discussion. Norman Dalkey of the Rand Corporation described some difficulties with face-to-face interaction [Ref. 11, p. 3] as follows:

> We've conducted experiments at Rand where we've convened groups and asked questions for which we knew the answers, but no one in the group really knew the answer. When the face-to-face discussion technique was used the answers of the group got worse after the discussion. We polled them beforehand, asking them to give their judgement on these questions; then we let them talk it through and reformulate their judgements. More often than not, after the discussion the judgements were worse than they were in the

> beginning. The major reason is that in a group discussion there are always one or two dominant individuals who take over the discussion and do most of the talking. In our experiments we found that you can almost predict the direction in which the group opinion is going to shift by just measuring the amount of time that each individual talks.

From the above it can be concluded that group opinion is highly influenced by the person who talks the most, and there is very little correlation between pressure of speech and knowledge.

A second element that interferes with arriving at sound judgement is the social situation that prevails. Much of the discussion has to do with maintaining prestige and relative position in the group. Individual and group interests that are not related to the problem solving purpose of convening the group consume much of the time and effort of the group.

A final consideration is group pressure for conformity. The group itself has an enormous effect and creates a strong pressure on the more timid members of the group to conform. Distortion of individual judgement can occur from group pressure.

B. DELPHI METHODOLOGY

The Delphi is a group process which utilizes written responses as opposed to bringing individuals together. It lets people remain anonymous and prevents domination by certain individuals. Delphi avoids the difficulties of face-to-face discussion and at the same time maintains the

obvious advantage of the group. Delphi is essentially a series of questionnaires. The first asks individuals to respond to a broad question. Each subsequent questionnaire is built upon responses to the preceding questionnaire. The process stops when concensus has been approached among participants, or when sufficient information exchange has been obtained [Ref. 12, p. 83].

Delphi was originally developed by the Rand Corporation in the late 1940's to obtain the most reliable consensus of a group of experts. Essentially, the Delphi is a series of intensive interrogations of individual experts concerning some primary question interspersed with controlled feedback. The procedures are designed to avoid direct confrontation.

Interaction among the experts is accomplished through an intermediary who gathers the data from the experts and summarizes it along with the expert's answers to the primary question. This mode of controlled interaction is a deliberate attempt to avoid the disadvantages associated with more conventional uses of experts such as is in round table discussions or direct confrontation of opposing views. The developers of the Delphi argue the procedures are more conducive to independent thought and allow more gradual formulation to a considered opinion [Ref. 13].

Typically, the answer to the primary question is a numerical quantity. It is expected that the individual experts' estimates will tend to converge as the experiment continues even if the estimates expressed initially are

widely divergent. Delphi involves three general ideas: anonymity, iteration and feedback, and statistical group response.

1. Anonymity

A formal questionnaire is the usual mode of communicating the opinions of members of the group and no answer is matched to an individual. Anonymity is a way of reducing the effect of dominant individuals. Delphi can also be used to aggregate judgements where people are hostile toward one another, or where individual personality styles would be distracting in a face-to-face setting.

2. Iteration and Feedback

The exchange of information or feedback is very carefully controlled by the intermediary. It is planned that the iteration occurs in a series of stages and at each stage the information which has been generated by the group in the previous stage is fed back. In this manner the socializing and personal interest discussions are eliminated and the views of individual experts are not subjected to criticism in face-to-face confrontation.

3. Statistical Group Response

Normally, after several iterations, the group opinion converges. That is, the individual opinions come closer and closer together, but do not come to a single opinion. There is always some distribution of answers, even on the final round, and rather than force a single opinion, a statistical measure is taken. The median or the mean is

used as the group response. Even at the very end, the opinion of every member of the group still plays a role in determining the group answer.

In experiments conducted by Dalkey [Ref. 11], he found that contrary to the results of the face-to-face type of iteration, as the exercise proceeds more often than not the opinions of the group become more accurate.

C. DELPHI PARTICIPANTS

The selection of a panel of participants is accomplished from persons who can exercise expert judgement in the area under consideration. The term "experts" is intended to describe persons who have important knowledge or experience to share. The persons selected to serve as the Delphi work group should possess relevant information or experience toward which the Delphi is aimed.

The ideal panel would be composed of persons who feel personally involved, are motivated to participate in the delphi study and have pertinent information to share. The size of the panel is variable, but with a homogeneous group not more than ten participants is recommended. This study, performed at the Naval Air Station Point Mugu Security Department, had a panel of six members, each of which was intimately knowledgeable in some phase of the security operation.

IV. DELPHI APPLIED

In developing measures of effectiveness for the Naval Air Station Security Department, the Delphi technique was used to arrive at quantitative goals for various indicators and to weight each indicator for relative importance in relation to the whole.

The key to the Delphi process is the questionnaire. If the respondents do not understand the initial broad questions they may answer inappropriately or become frustrated with the questionnaire and lose interest.

A. THE DELPHI QUESTIONNAIRE FOR ESTABLISHING GOAL

The questions submitted to the group experts were formulated to provide an indication of the security performance. A study of the department mission statement was accomplished to extract information that could be formulated into goal directing effort of a primary objective nature.

Six questions were prepared. The questions fulfill the requirement that they will provide an indication of primary objective effectiveness. Three questions relate to base admission and one each to unauthorized material, unsecured safes and reaction time. The purpose of the questionnaire was to evolve a numerical value for each indicator that could be used as the goal in striving for high effectiveness. The questions and a discussion of each follows:

1. *Base Admission*

Out of every 100 unauthorized persons who might try to gain access to the installation through normal entry gates, what is the minimum number that should be detected by the gate guards?

Entry of persons to the installation is accomplished by displaying an identification badge to the gate guard. All personnel, military, dependents, civilian employees and visitors are issued identification badges that are required to be worn on outer clothing when in a classified area. The color of the badge indicates the type of security clearance held by the individual.

Passengers in vehicles entering the installation hold their identification out for inspection by the gate guard before being waved through. The identification badge has the bearer's picture, name, activity and department on the face. The reverse side has other vital statistics.

This question recognizes the fallibility of attempting to maintain 100% authorized only entry. In considering monetary and manpower constraints the question is, how many unauthorized entries are we willing to live with? In the first iteration the mean was 95 or stated another way, 5% unauthorized entries are acceptable. The second iteration had minor changes in the wording. In place of asking for "the minimum number that should be detected," the wording was changed to "minimum acceptable number that should be detected." This change was made for clarity purposes.

The mean value on the second iteration, accepted as the group concensus, was 98 (see Table I). The goal established for this indicator was 2% of unauthorized entries will be acceptable. Anything more than 2% would be an indication of lowered effectiveness.

2. *Base Admission*

Out of every 100 unauthorized persons who might try to gain access to the installation through other than normal entry gates, what is the minimum acceptable number that should be detected by the security force?

The Naval Air Station, Point Mugu, has several miles of ocean frontage. Undetected access in remote areas is feasible under certain conditions. Recognizing this fact, the group mean for this question was 44 for the first iteration and 61 for the second. Most of the estimates were raised on the second round after considered judgement and a review of the answers to the first set.

3. *Base Admission*

Out of every 100 unauthorized vehicles that might try to gain access to the installation through normal entry gates, what is the minimum acceptable number that should be detected by the gate guards?

A vehicle is given authorization to be driven on the installation if the owner maintains at least a minimum value insurance coverage and the vehicle passes a routine safety inspection. Evidence of authorization is demonstrated by a base decal affixed to the bumper, or on other exposed area if other than a car or truck. Temporary vehicle passes are issued by the visitor control desk for official visitors. When a vehicle approaches the gate, the

RESULTS OF QUESTIONNAIRE FOR ESTABLISHING GOALS

QUESTION NUMBER	FIRST ITERATION						$\bar{X}_1$	SECOND ITERATION						$\bar{X}_2$
1	90	90	95	98	99	100	95	90	99	100	100	100	100	98
2	2	10	10	50	90	100	44	10	10	50	95	99	100	61
3	50	100	100	100	100	100	92	90	99	100	100	100	100	98
4	0	5	10	10	23	100	25	2	5	10	10	75	99	33
5														
4 - hours	30	-	-	-	-	-		10	50	50	100	100	-	62
8 - hours	4	20	90	100	100	100		15	100	100	100	100	100	86
12 - hours	10	-	-	-	-	-		100	100	100	100	100	100	100
24 - hours	10	-	-	-	-	-		-	-	-	-	-	-	
6	1½	2	2	5	5	5	3.4	3	5	5	5	5	-	4.6

Table I

security guard will glance at the vehicle decal and then at the driver and passenger identification before allowing admittance.

Violations can occur by not having a vehicle decal or temporary pass, or having an out-of-date decal that might indicate expiration of the driver's insurance. The Delphi group indicated 92% on the first questionnaire and 98% on the second. The high numerical value is an indication of the ease of detection of unauthorized vehicles. On the first round, five out of six participants assigned values of 100% to this item. The second iteration had four out of six.

4. *Unauthorized Material*

Out of every 100 cases where an individual might try to bring unauthorized material aboard the base (guns, explisives, drugs, etc.), what is the minimum acceptable number that should be detected by the security force?

Detection of unauthorized material is most difficult when no search is initiated of incoming persons or vehicles. When a security guard suspects unauthorized material is being covertly brought aboard he will institute a search.

The mean value for this item on the first iteration was 25. One participant assigned a value of zero. This was changed on the second iteration where the mean rose to 33.

5. *Unsecured Safes*

Out of every 100 cases where a classified material storage container has been left unsecured by the appropriate custodian, how many should be detected by the security force?

(1) Within 4 hours
(2) Within 8 hours
(3) Within 12 hours
(4) Within 24 hours

Most buildings are secured after hours and no entry is made until the start of the next work day. Headquarters buildings are continuously manned. Individual offices however, are locked at night after the custodial crew completes its work. Unsecured classified material safes may be discovered by the custodian or the security guard making a routine check.

Results of the first questionnaire were incomplete so clarifying remarks were provided for the second one. The group mean for this question showed:

(1) Within 4 hours 62%
(2) Within 8 hours 86%
(3) Within 12 hours 100%

6. *Reaction Time*

When a security alarm is sounded anywhere on the installation, what is the maximum acceptable time (in minutes) between when the alarm is sounded and the security force reaches the scene of the incident?

When a security alarm is sounded, it alerts the dispatcher in the security building. The dispatcher's desk is manned on a 24-hour basis. The dispatcher in turn notifies the security patrol by radio communication and the security patrol proceeds to the scene of the incident.

On the first iteration, the Delphi group assigned a mean value of 3.4 minutes for the security patrol to respond to the alarm. The second iteration had a mean of 4.6 minutes which was the accepted value for this item.

B. THE DELPHI QUESTIONNAIRE FOR ESTABLISHING WEIGHTS

To provide a department effectiveness measure, it is necessary to integrate the various indicators into one overall rating. The method for doing this is to weight each indicator so that a maximum value of 100% will be obtained if the organization meets the goal established for each indicator. Indicator number six on the Delphi questionnaire is cited as an example of how this is done. The statement is, "When a security alarm is sounded anywhere on the installation, the maximum acceptable time between when the alarm is sounded and when the security force reaches the scene of the incident is 4.6 minutes." This indicator is given a weight of 32%. If it is determined that the average response time during the reckoning period is 5.4 minutes, then 88% of the goal has been achieved. The weighted score for this indicator would then be 88% x 32% = 27%. Each of the indicators would be weighted in this manner, and the weighted values would be summed up to give a department effectiveness index. The weight for each indicator was established by using the Delphi method in the same manner that the goals were established. See Table II for summary of weighting values.

The six indicators that were used to establish goals were again incorporated into a questionnaire to gain the group concensus of weighting values to assign. The questions and a discussion of each follows:

RESULTS OF QUESTIONNAIRE FOR ESTABLISHING WEIGHTING VALUES

QUESTION NUMBER	FIRST ITERATION						$\bar{X}_1$	SECOND ITERATION						$\bar{X}_2$
1	2	10	10	10	10	10	9	5	5	10	10	10	15	9
2	2	10	10	10	10	10	9	5	5	10	10	10	10	8
3	2	3	4	5	10	10	5	5	5	5	10	10	10	7
4	1	2	5	10	10	14	7	5	10	10	10	20	20	13
5	20	30	40	45	45	50	38	20	20	25	30	40	55	32
6	15	25	30	30	30	60	32	20	25	30	30	30	50	31

Table II

1. *Base Admission*

Out of every 100 unauthorized persons who might try to gain access to the installation through normal entry gates, 98 should be detected by the gate guards.

The Delphi group gave this indicator a weight of nine on the first iteration, and again nine on the second. The low value of two and the top value of ten were both increased on the second round. The increase was insufficient however, to raise the mean higher than nine.

2. *Base Admission*

Out of every 100 unauthorized persons who might try to gain access to the installation through other than normal entry gates, 81 should be detected by the security force.

This item was assigned a weight of nine on the first iteration and eight on the second. The Delphi group saw little relative difference between this indicator and the first one which was given a weight of nine. The scores had very little variance indicating a general concensus at an early stage.

3. *Base Admission*

Out of every 100 unauthorized vehicles that might try to gain access to the installation through normal entry gates, 98 should be detected by the gate guards.

Here again, differences between the first and second iteration were small. The mean value was five on the first round and seven on the second. The goal for this indicator was established at 98%, almost a completely perfect target, yet, the security experts relegated this item to the lowest relative standing of the entire group.

4. *Unauthorized Material*

Out of every 100 cases where an individual might try to bring unauthorized material aboard the base, (guns, explosives, drugs, etc.), 33 should be detected by the security force.

Weighting for this item was seven on the first round, but was increased to 13 on the second. Some of the lowest values were placed on this one in the first iteration. The final weighting moved the item to a relative standing of third from the top.

5. *Unsecured Safes*

Out of every 100 cases where a classified material storage container has been left unsecured by the appropriate custodian, 62 should be detected within 4 hours, 86 should be detected within 8 hours, 100 should be detected within 12 hours.

This item received the highest weight by the Delphi group. It was given a value of 38 on the first iteration and 32 on the second. Unsecured classified material is considered to be the most serious security infringement of all the indicators. In discussing this item with the assistant security officer, he expressed the thought that all other security effort was more or less in support of this one.

6. *Reaction Time*

When a security alarm is sounded anywhere on the installation, the maximum acceptable time between when the alarm is sounded and when the security force reaches the scene of the incident is 4.6 minutes.

This last item was ranked second in importance by the rating group. On the first iteration it was given a weight of 32 which was changed to 31 on the second round.

Reaction time is considered to be of major importance to base security and the maximum acceptable time of 4.6 minutes is an indication of the effort expended in reacting to an alarm.

C. INTEGRATING THE ELEMENTS

Having established specific objectives and having each objective weighted, it is now necessary to combine the various elements into a single index of effectiveness. To accomplish this, a measure of achievement in relation to the objective will be required. This measure may be acquired using one of the methods described earlier. To illustrate how a single index is derived, a hypothetical situation is described.

Table III lists the six objectives and their numerical goals in column 1. The weight assigned to each objective is shown in column 2. The achievement of the security force toward each goal is in column 3. The values listed in column 3 are hypothetical and are used to illustrate the mechanics involved in determining tbe effectiveness index. Column 4 is the percentage of achievement of the goal and is computed by dividing the percentage achievement in column 3 by the values in column 1. The weighted valuation shown in column 5 is derived by multiplying the percentage of goal in column 4 by the weight in column 2.

It is evident from Table III that the objectives given a low weight contribute only a small part to the effectiveness index. Item 3 achieved 100% of the goal, but because of a

SECURITY DEPARTMENT MEASURE OF EFFECTIVENESS

HYPOTHETICAL EXAMPLE

(1) SPECIFIC OBJECTIVES	(2) WEIGHT	(3) HYPOTHETICAL ACHIEVEMENT	(4) PERCENT OF GOAL (3) ÷ (1) *	(5) WEIGHTED VALUATION (4) X (2)
1. Detect 98% unauthorized persons at entry gates	9%	90%	92%	8.3%
2. Detect 61% unauthorized persons at other than entry gates	8%	55%	90%	7.2%
3. Detect 98% unauthorized vehicles at entry gates	7%	98%	100%	7.0%
4. Detect 33% cases of unauthorized material brought aboard base	13%	20%	61%	7.9%
5. Detect 100% unsecured classified material storage container within 12 hours	32%	75%	75%	24.0%
6. Maximum reaction time is 4.6 minutes	31%	5.2 min.	88%	27.3%
	100%		EFFECTIVENESS INDEX	81.7%

* Objectives 1 through 5 are minimum values. Percentage of goal is calculated by dividing column 3 by column 1 and multiplying quotient by 100. Objective 6 is a maximum value, so percentage of goal is calculated by dividing column 1 by column 3 and multiplying quotient by 100.

Table III

weight of 7% contributed only 7% to the effectiveness index. It is hypothetically possible to score an effectiveness index greater than 100%, if the degree of goal achievement is greater than 100% for several of the objectives. In such a case it will be necessary to evaluate the numerical goal to determine if a revision is warranted.

The effectiveness index calculated in Table III is 81.7%. Once the index is determined, a periodic evaluation is possible. Now an objective rating can be applied with the confidence that the measure of effectiveness is a reflection of the department effort.

V. CONCLUSION

A. COST CONSIDERATIONS

In the planning and development of security effectiveness measures it was necessary to estimate the resource input that would be applied. Budgetary and manpower limitations make it infeasible to consider the application of more funds or manpower than has been allocated to the department. The model developed here assumes no change in resource input, but sensitivity analysis can be undertaken to determine the extent of a change in effectiveness by increasing or decreasing funds or manpower.

It was stated earlier that 100% assurance can not be given that a security violation will go undetected. One of the effectiveness indicators relating to base admission states that "out of every 100 unauthorized persons who might try to gain access to the installation through other than normal entry gates, 61 should be detected by the security force." We could ask, what would be the increase in cost to raise the figure to some number higher than 61?

The problem is to determine whether an additional amount of effectiveness is worth the added amount of cost. There are two methods for analysis of this problem without resorting to a purely intuitive decision [Ref. 14, p. 72].

1. Specify a level of effectiveness which must be met, and select that method which meets this level at lowest total cost.

2. Specify a level of cost which must not be exceeded, and select that method which provides the highest level of effectiveness without exceeding that cost.

Usually there is no one level of performance which can be stated as an absolute requirement. For example, consider the case mentioned above, where 61 out of 100 unauthorized entries would be detected. It follows that the more funds spent for security, the more protection would be provided, though not necessarily in a one to one ratio.

Presenting the decision maker with a comparison of level of effectiveness and cost by using the method above, the optimum level can be chosen.

The resources expended to achieve a given objective can in most cases be put in money terms; hence we try to compare benefits or effectiveness with the cost incident to it. What makes the problem difficult is that the benefits are far more difficult to place on a monetary scale, and the benefits are usually displaced in time from the expenditure of resources.

B. APPLICATION OF TECHNIQUE TO OTHER FUNCTIONS

When faced with limitations of time and money, a perfunctory analysis can not treat all the considerations that may be relevant. In dealing with intangibles, judgement and intuition can be applied, but deficiencies in quantitative measurements are apparent. In dealing with difficult to quantify considerations, it is the systematic and direct use

of expert judgement that provides a framework for decision making.

A single individual is not likely to provide the range of expertise necessary to deal with complex problems. It is inevitable that a variety of experts be consulted. It is for this reason, and to avoid the psychological drawbacks of face-to-face discussion that the Delphi method was adopted.

The model described herein is not intended to be restricted to a security organization to the exclusion of other functions. Its application is appropriate to recreation, administration, personnel, legal, air operations, human resources and other support type functions. The Delphi technique provides a bridge to where scientific analysis and objectivity are employable. It is a method to make the difficult to quantify considerations easier to manipulate.

APPENDIX

This appendix contains the questionnaire and the results of each iteration for establishing quantitative goals and for weighting each goal.

QUESTIONNAIRE FOR SECURITY PLANNING

This questionnaire is the first in a series designed to gain information related to managing the security effort. This information will assist in providing insight into the most important areas of security aboard the installation, the allocation of resources to those areas of importance, and measuring the effectiveness of the ongoing security program. Your expertise in the security field will assist in developing these insights. Responses will not be attributed to the individual, but composite results will be distributed to each participant. Please reply carefully and thoughtfully, from your professional point of view.

1. Below is a list of indicators which might be used to help measure the effectiveness of the security force. For each indicator listed, please indicate the number of violations, in a one month period, that you would consider as a minimum acceptable operating target for the security force under current funding and manpower levels.

a. BASE ADMISSION. Out of every 100 unauthorized persons who might try to gain access to the installation through normal entry gates, what is the minimum number that should be detected by the gate guards?
(Example of possible answer - 75) _____

b. BASE ADMISSION. Out of every 100 unauthorized persons who might try to gain access to the installation through other than normal entry gates, what is the minimum number that should be detected by the security force? _____

QUESTIONNAIRE FOR SECURITY PLANNING

This questionnaire is the first in a series designed to gain information related to managing the security effort. This information will assist in providing insight into the most important areas of security aboard the installation, the allocation of resources to those areas of importance, and measuring the effectiveness of the ongoing security program. Your expertise in the security field will assist in developing these insights. Responses will not be attributed to the individual, but composite results will be distributed to each participant. Please reply carefully and thoughtfully, from your professional point of view.

1. Below is a list of indicators which might be used to help measure the effectiveness of the security force. For each indicator listed, please indicate the number of violations, in a one month period, that you would consider as a minimum acceptable operating target for the security force under current funding and manpower levels.

a. BASE ADMISSION. Out of every 100 unauthorized persons who might try to gain access to the installation through normal entry gates, what is the minimum number that should be detected by the gate guards?
(Example of possible answer - 75) _____

b. BASE ADMISSION. Out of every 100 unauthorized persons who might try to gain access to the installation through other than normal entry gates, what is the minimum number that should be detected by the security force? _____

c. BASE ADMISSION. Out of every 100 unauthorized vehicles that might try to gain access to the installation through normal entry gates, what is the minimum number that should be detected by the gate guards? _____

d. UNAUTHORIZED MATERIAL. Out of every 100 cases where an individual might try to bring unauthorized material aboard the base (guns, explosives, cameras, drugs, etc.), how many should be detected by the security force as a minimum? (Be realistic). _____

e. UNSECURED SAFES. Out of every 100 cases where a classified material storage container has been left unsecured by the appropriate custodian, how many should be detected by the security force?

(1) Within 4 hours? _____

(2) Within 8 hours? _____

(3) Within 12 hours? _____

(4) Within 24 hours? _____

f. REACTION TIME. When a security alarm is sounded anywhere on the installation, what is the minimum acceptable reaction time with which the security force should respond? _____

2. What additional quantitative indicators can you think of which are not presently included in the above list?

6 July 1976

RESULTS OF THE FIRST QUESTIONNAIRE
FOR SECURITY PLANNING

1. Six responses to the initial questionnaire were received.

2. Results of the first four questions are:

	a	b	c	d
	90	10	100	10
	100	10	50	0
	90	50	100	5
	95	90	100	10
	99	2	*100	23
	98	100	100	100
Mean (average)	95	44	92	25

*Rounded to 100 by the referee

QUESTIONS

a. BASE ADMISSION. Out of every 100 unauthorized persons who might try to gain access to the installation through normal entry gates, what is the minimum number that should be detected by the guards?

b. BASE ADMISSION. Out of every 100 unauthorized persons who might try to gain access to the installation through other than normal entry gates, what is the minimum number that should be detected by the security force?

c. BASE ADMISSION. Out of every 100 unauthorized vehicles that might try to gain access to the installation through normal entry gates, what is the minimum number that should be detected by the gate guards?

d. UNAUTHORIZED MATERIAL. Out of every 100 cases where an individual might try to bring unauthorized material aboard the base, how many should be detected by the security force as a minimum?

3. The fifth question referred to unsecured safes and asked: Out of every 100 cases where a classified material storage container has been left unsecured by the appropriate custodian, how many should be detected by the security force?

Question 3 continued.

Within 4 Hours	Within 8 Hours	Within 12 Hours	Within 24 Hours
-	90	-	-
-	100	-	-
-	100	-	-
-	100	-	-
-	4	-	-
30	20	10	10

4. The last question asked: When a security alarm is sounded anywhere on the installation, what is the minimum reaction time with which the security force should respond?

ANSWERS

5 Min
5 Min
5 Min
2 Min
2 Min
1½ Min

Mean 3.4 Min

6 July 1976

QUESTIONNAIRE FOR SECURITY PLANNING

This is a continuation of the exercise which began 9 June 1976. The results are attached. Please answer the reworded questions that are provided below. If your new answer lies at one of the extreme ends of the list of previous answers that were given for the same question, please state briefly the reason why.

1. BASE ADMISSION. Out of every 100 unauthorized persons who might try to gain access to the installation through normal entry gates, what is the minimum acceptable number that should be detected by the gate guard? _____

2. BASE ADMISSION. Out of every 100 unauthorized persons who might try to gain access to the installation through other than normal entry gates, what is the minimum acceptable number that should be detected by the security force? _____

3. BASE ADMISSION. Out of every 100 unauthorized vehicles that might try to gain access to the installation through normal entry gates, what is the minimum acceptable number that should be detected by the gate guards? _____

4. UNAUTHORIZED MATERIAL. Out of every 100 cases where an individual might try to bring unauthorized material aboard the base (guns, explosives, drugs, etc.), what is the minimum acceptable number that should be detected by the security force? _____

5. UNSECURED SAFES. Out of every 100 cases where a classified material storage container has been left unsecured by the appropriate custodian, how many should be detected by the security force?

(1) Within 4 hours? _____
(2) Within 8 hours? _____
(3) Within 12 hours? _____
(4) Within 24 hours? _____

Note: Fill in each blank space. Example of possible answers:

(1)	10
(2)	30
(3)	75
(4)	99

6. REACTION TIME. When a security alarm is sounded anywhere on the installation, what is the maximum acceptable time (in minutes) between when the alarm was sounded and the security force reaches the scene of the incident? _____

12 July 1976

QUESTIONNAIRE FOR SECURITY PLANNING

This is a continuation of the exercise for security planning. The items addressed in previous questionnaires are repeated below, but this time values are given for each item. These values are medians that were calculated from the group answers provided in the last questionnaire.

You are now asked to weight each item. One hundred (100) points are to be distributed to the various items based on your perception of the relative importance of that item within the list. Please distribute these 100 points in the space provided, so that the sum equals 100.

1. _____ BASE ADMISSION. Out of every 100 unauthorized persons who might try to gain access to the installation through normal entry gates, 98 should be detected by the gate guards.

2. _____ BASE ADMISSION. Out of every 100 unauthorized persons who might try to gain access to the installation through other than normal entry gates, 61 should be detected by the security force.

3. _____ BASE ADMISSION. Out of every 100 unauthorized vehicles that might try to gain access to the installation through normal entry gates, 98 should be detected by the gate guards.

4. _____ UNAUTHORIZED MATERIAL. Out of every 100 cases where an individual might try to bring unauthorized material aboard the base, (guns, explosives, drugs, etc.), 33 should be detected by the security force.

5. _____ UNSECURED SAFES. Out of every 100 cases where a classified material storage container has been left unsecured by the appropriate custodian,
   62 should be detected within 4 hours
   86 should be detected within 8 hours
   100 should be detected within 12 hours

6. _____ REACTION TIME. When a security alarm is sounded anywhere on the installation, the maximum acceptable time (in minutes) between when the alarm was sounded and when the security force reaches the scene of the incident is 4.6.

100 TOTAL

20 July 1976

RESULTS OF THE QUESTIONNAIRE FOR WEIGHTING SECURITY GOALS

1. Six responses to the questionnaire were received.

2. Individual and average weight for each question are given in the following table.

Question Numbers

1	2	3	4	5	6	
2	2	2	1	20	15	
10	10	3	2	30	25	
10	10	4	5	40	30	
10	10	5	10	45	30	
10	10	10	10	45	30	
10	10	10	14	50	60	
9	9	5	7	38	32	Average

20 July 1976

QUESTIONNAIRE FOR SECURITY PLANNING

This is a continuation of the exercise for security planning. The results of the previous questionnaire for weighting the different items are attached.

You are asked to reconsider the answers you have previously given, and to again place weighting values on each item. The same procedure is to be used as before, where 100 points are to be distributed to the various items based on your perception of the relative importance of the items within the list.

1. _____ BASE ADMISSION. Out of every 100 unauthorized persons who might try to gain access to the installation through normal entry gates, 98 should be detected by the gate guards.

2. _____ BASE ADMISSION. Out of every 100 unauthorized persons who might try to gain access to the installation through other than normal entry gates, 61 should be detected by the security force.

3. _____ BASE ADMISSION. Out of every 100 unauthorized vehicles that might try to gain access to the installation through normal entry gates, 98 should be detected by the gate guards.

4. _____ UNAUTHORIZED MATERIAL. Out of every 100 cases where an individual might try to bring unauthorized material aboard the base, (guns, explosives, drugs, etc.), 33 should be detected by the security force.

5. _____ UNSECURED SAFES. Out of every 100 cases where a classified material storage container has been left unsecured by the appropriate custodian,

62 should be detected within 4 hours
86 should be detected within 8 hours
100 should be detected within 12 hours

6. _____ REACTION TIME. When a security alarm is sounded anywhere on the installation, the maximum acceptable time between when the alarm was sounded and when the security force reaches the scene of the incident is 4.6 minutes.

100 TOTAL

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